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OPERABLE UNIT 1
EXPANDED TREATABILITY STUDY
INSTALLATION REPORT

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JET PROPULSION LABORATORY
PASADENA, CALIFORNIA

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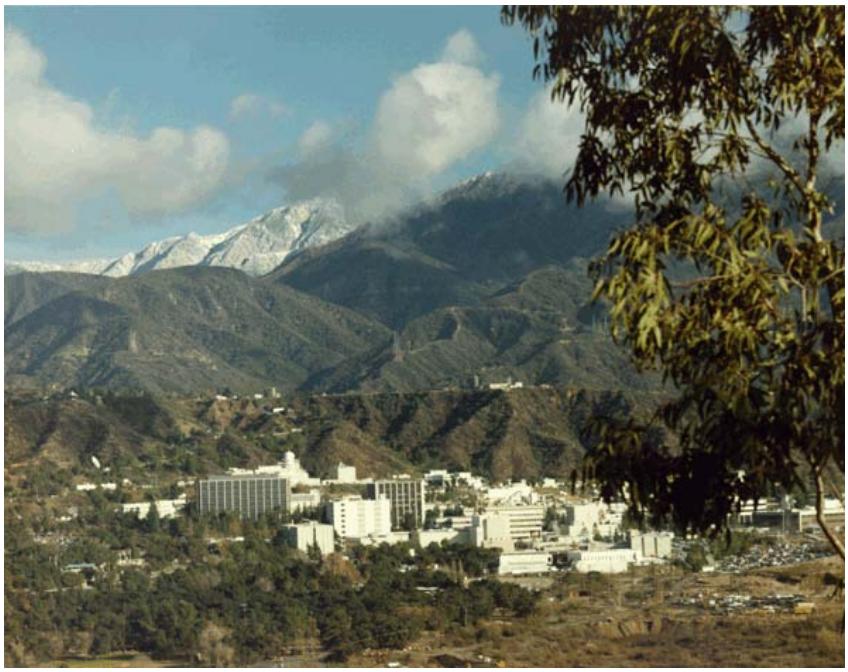

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ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
btoc	below top of casing
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DO	dissolved oxygen
EW	extraction well
FBR	fluidized bed reactor
GAC	granular activated carbon
ID	internal diameter
IW	injection well
JPL	Jet Propulsion Laboratory
MW	monitoring well
NASA	National Aeronautics and Space Administration
NPL	National Priorities List
ntu	nephelometric turbidity units
ORP	oxidation-reduction potential
OU	Operable Unit
pH	percent hydrogen
psi	pounds per square inch
PVC	polyvinyl chloride
SARA	Superfund Amendments and Reauthorization Act
Sch	schedule
U.S. EPA	United States Environmental Protection Agency
UV	ultraviolet
VOC	volatile organic compound

1.0 INTRODUCTION

This report was prepared for the National Aeronautics and Space Administration (NASA) to document installation of the expanded treatability study system in Operable Unit 1 (OU-1) at the Jet Propulsion Laboratory (JPL). The NASA-JPL site is on the United States Environmental Protection Agency (U.S. EPA) National Priorities List (NPL) and subject to the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA).

Expanded treatability testing has been initiated to address chemicals of interest in OU-1, on-facility groundwater (NASA, 2004). The Phase I system consists primarily of two extraction wells, two injections wells, underground piping, the treatment system, and ancillary equipment. The extraction wells (EW-01, EW-02) are located east of Building 18. The treatment plant is located near monitoring well MW-7. The two injection wells are located upgradient of the extraction wells at a distance of approximately 330 ft. The first injection well (IW-01) is located adjacent to the east side of Building 140, and the second injection well (IW-02) is located adjacent to the south side of Building 299. Figure 1-1 shows the layout of the system. Figure 1-2 is a picture of the treatment plant taken on February 24, 2005.

The remainder of this report is divided into five sections. Section 2.0 provides information pertaining to the installation of OU-1 wells. Section 3.0 describes the approach that

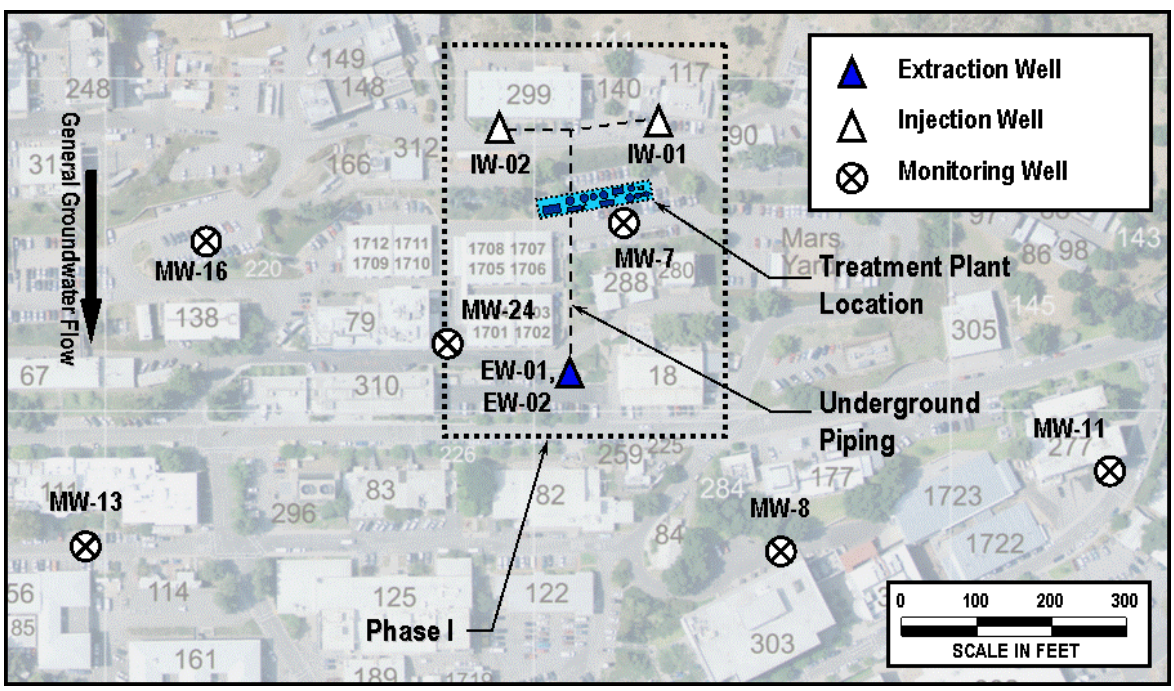

Figure 1-1. Layout of the Expanded Treatability Study System

Figure 1-2. OU-1 Treatment Facility February 24, 2004

was taken to establish a proper foundation for the OU-1 treatment system and Section 4.0 describes the installation of the major components that make up the expanded treatability study system. Section 5.0 provides references. The appendices are divided into three different categories, each dealing with a different phase of the work. Appendices 2-1 thru 2-6 contain waste manifests, lab results, boring logs, development logs, test results, and completion diagrams. This information deals directly with the well installation phase of the installation. Appendices 3-1 thru 3-4 contains, a map, abandoned well logs, geotechnical reports, and field reports. All of this information relates to the foundation construction portion of the work. Appendices 4-1 thru 4-4 contain civil, electrical, and mechanical installation drawings.

2.0 WELL INSTALLATION

This section describes the pre-drilling and construction activities utilized during the installation of the OU-1 Expanded Treatability Study. The groundwater extraction wells were completed at two different depths, one shallow and one deep. JPL extraction well 1 (JPL-EW-01), the shallow well, was completed to 268 ft below ground surface (bgs) and JPL-EW-02, the deep well, was completed to 315 ft bgs. Both injection wells, JPL-IW-01 and JPL-IW-02, were constructed to 315 ft bgs.

2.1 Utility Locating

A full map review was conducted in the JPL map database and a utility survey was completed. The review and survey were conducted in order to allow drilling/construction operations to safely avoid any existing utilities. A utility survey utilizes electromagnetic utility locating instruments to penetrate the ground surface and detect any pipelines. These lines are then field marked with paint so that they are physically visible. Once all known utilities had been located the drilling locations were selected.

2.2 Drilling Method

The extraction and injection wells were drilled using a mud-rotary method and a 12.25-inch-diameter bit. The drill rig used is pictured in Figure 2-1. A 20-foot surface casing was installed to maintain the integrity of the surface. Mud-rotary drilling requires the constant use of drilling mud and a mud shaker. The mud shaker is responsible for separating the drill cuttings and recycling the drilling mud. The bentonite drilling mud is monitored by the driller for weight, viscosity, and sand content. This monitoring provides the driller with the ability to maintain borehole stability, fluid loss, and equipment integrity. The processed soil cuttings were removed and stored in roll-off bins. Additional details of the storage and disposal of the IDW waste are provided in Appendix 2-1.

All drilling equipment and materials including drilling bits and pipes, drilling mud components, and backfill equipment were either new or cleaned in the field using a high pressure steam cleaner. Water used during drilling and well construction activities was water from a nearby JPL fire hydrant. Prior to use, a water sample was collected from the fire hydrant and analyzed for VOCs and perchlorate using U.S. EPA approved methods. Results from the fire hydrant samples are as Appendix 2-2.

2.3 Well Construction

JPL-EW-01 was constructed with a casing span of 0 ft bgs to 218 ft bgs with a 50-ft screened interval that spans from 218 ft bgs to 268 ft bgs. The casing material is 6-inch

Figure 2-1. Drilling Activities IW-01 February 24, 2004

low carbon steel and the screen is a 6-inch 0.40 slot stainless steel. JPL-EW-02 was constructed with a casing span of 0 ft to 265 ft bgs with a 50-ft screened interval that spans from 265 ft bgs to 315 ft bgs. The casing material is 6-inch low carbon steel and the screen is a 6-inch .40 slot stainless steel.

JPL-IW-01 and JPL-IW-02 were both constructed with a casing span of 0 ft bgs to 215 ft bgs with a 100-ft screened interval that spans from 215 ft bgs to 315 ft bgs. The casing material is 6-inch low carbon steel and the screen is a 6-inch .50 slot stainless steel. The larger screen slot size was chosen for the injection wells to allow for maximum flow into the aquifer.

Table 2-1 provides a summary of the well construction details. Further details can be found on the boring logs in Appendix 2-3.

Table 2-1. OU-1 Well Construction Details

Well Number	Screen Depth (ft bgs)	Casing Depth (ft bgs)	Casing I.D. (inches)	Casing Material	Screen Material
JPL-EW-01	218 to 268	269	6	Low Carbon Steel	Stainless Steel .40 slot
JPL-EW-02	265 to 315	316	6	Low Carbon Steel	Stainless Steel .40 slot
JPL-IW-01	215 to 315	316	6	Low Carbon Steel	Stainless Steel .50 slot
JPL-IW-02	215 to 315	316	6	Low Carbon Steel	Stainless Steel .50 slot

When drilling was complete each well was surveyed using various down well logging techniques to assist field geologist in their evaluation. The following methods were used:

- **Gamma Log**. This method records the amount of natural gamma radiation emitted by the rocks surrounding the borehole. Clay bearing and shale bearing zones often emit relatively high gamma radiation because they include weathering products that include uranium and thorium.

- **Single-Point Resistance Log.** This method records the electrical resistance from points within the borehole to an electrical ground at the surface. Typically, resistance increases with increasing grain size and decreases with increasing borehole diameter, fracture density, and dissolved-solids concentrations of the water.

- **Spontaneous-Potential Log.** This method records potentials or voltages developed between the borehole fluid and the surrounding rock and fluids. Spontaneous-potential logs can be used in the determination of lithology and water quality.

The geotechnical survey results can be viewed in Appendix 2-3. Additional details regarding well design and construction, mud rotary drilling and geophysical methodologies, can be found in NASA's approved *Work Plan for Performing a Remedial Investigation/Feasibility Study at NASA JPL* (Ebasco, 1993).

2.4 Well Development

The purpose the well development procedure was to remove residual drilling mud to the extent practical, and establish hydraulic communication between the borehole wall and the filter pack material surrounding the well screen sections. During well development the screened interval at each well was swabbed using a rubber-disc swab tool. During this process, aquifer sediments that accumulated on the bottom of each well were removed using a bailer. Following swabbing and bailing operations, each screened interval was individually purged using a submersible pump. Based on the amount of fines that were being recovered during purging, the pumping was occasionally discontinued to surge the interval being developed.

The progress of the development of each screened interval was measured by monitoring the physical and chemical properties of the water produced (pH, electrical conductivity, temperature, dissolved oxygen (DO), salinity, oxidation reduction potential (ORP) and turbidity). When these properties approached stability (two consecutive parameter readings within 10% of each other) and the water turbidity was less than 5 ntu, or visibly clears, the well development was considered complete. All equipment used during development procedures were steam cleaned before use in each well. Table 2-2 provides a summary of the well development activities. The development logs for each well are available in Appendix 2-4.

Table 2-2. Well Development Summary

Well Number	Total Time (minutes)	Total Purge (gallons)	Water Level Start (ft btoc)	Water Level Finish (ft btoc)
JPL-EW-01	344	16,082	185	179.43
JPL-EW-02	350	15,548	185	182.89
JPL-IW-01	242	8,632	214	124.36
JPL-IW-02	350	6,550	223	233.15

The well development water was contained in 22,000-gallon Baker tanks, the same tanks used to contain the used drilling mud. The water was stored until the appropriate method of disposal was determined pursuant to EPA guidelines on the management of investigation-derived wastes (EPA, 1991a and 1992b). Waste manifests are available in Appendix 2-1.

2.5 Aquifer Testing

The hydraulic characteristics of the aquifer beneath the JPL facility were evaluated using a pumping test and slug/bail tests. The location of the pump test was in the deepest extraction well, JPL-EW-02. The objectives of the pump test were to obtain information about the well production capacity, drawdown, and the impact on surrounding wells. Additionally, three slug/bail tests were performed in each well by subsequently lowering and raising the 5-in diameter by 15-ft long slug into the water column once the water level had rebounded to static conditions. A pressure transducer located in the well collected water level readings at 0.5 second intervals throughout the duration of the test.

The results of the aquifer testing are summarized as follows:

- Hydraulic conductivity values estimated from the slug/bail aquifer tests correlate with those previously measured at the site.
- Hydraulic conductivity values estimated from the aquifer pumping test were slightly higher than those previously identified at the site.

A technical memorandum was prepared to document the aquifer testing and is provided as Appendix 2-5.

2.6 Wellhead Completions

The four wells installed as part of the expanded treatability study all have traffic-rated sub-surface well vaults. The two extraction wellheads are very similar in construction. The injection wellheads are both identical in their construction as well. Table 2-3 provides a summary of the wellhead completions. The diagrams for each well are available in Appendix 2-6.

Table 2-3. Wellhead Completions

Well	Pump	Pressure Transducer	Well Seal	Union Present
EW-01	50 gpm	Down Well	Expansion	Yes
EW-02	125 gpm	Down Well	Expansion	Yes
IW-01	NA	Surface	Weld Flange	Yes
IW-02	NA	Surface	Weld Flange	Yes

3.0 FOUNDATION

The treatment plant is located on a concrete pad for containment and stability reasons. The location can also be found in plot D-3 on the JPL site map, Appendix 3-1.

3.1 Well Abandonment

The location of the concrete pad required abandonment of four existing wells that were installed during in situ bioremediation pilot testing. Table 3-1 summarizes the wells that were abandoned. The locations and boring logs for those wells are included as, Appendix 3-2.

Table 3-1. Abandoned Well Characteristics

Well Number	Screen Depth (ft bgs)	Casing Depth (ft bgs)	Casing I.D. (inches)	Casing Material	Screen Material
IRZ-MW1	225 to 279	280	4	Sch 40 PVC	.02 slot Stainless
IRZ-MW2	224 to 252	253	4	Sch 40 PVC	.02 slot Stainless
IRZ-MW3	225 to 279	280	4	Sch 40 PVC	.02 slot Stainless
IW-1	224 to 252	253	4	Sch 40 PVC	.02 slot Stainless

The procedure followed for the abandonment of each well was identical. The wells were emptied of any secondary down well items (drop tubes, pumps, pressure transmitters) and filled with a combination of cement and grout. The fill mixture consisted of 55 gallons of water, 282 pounds of cement, and 15 pounds of well grout. When filling the wells a drop tube and packer seal were sent down well and the screened interval was filled in ten foot lifts at approximately 150-200 psi. When the screened interval and surrounding formation was filled to pressure, the remaining casing was filled in 10- to 20-foot lifts at 150-200 psi. Each well used approximately 400-500 gallons of the fill mixture to complete the abandonment effort. The surface completions for all wells were disposed of and the surface was returned to grade.

3.2 Geotechnical Survey

A geotechnical evaluation was conducted in order to determine what foundation requirements would be needed for the treatment facility foundation. The geotechnical evaluation consisted of the following:

- Three exploratory boring were drilled to depths of 8½ to 9½ ft. Samples were retrieved for classification and geological laboratory testing.

- Physical and engineering properties of the subsurface soils were determined by visually classifying the samples and performing various geotechnical laboratory tests on select samples.

- Geotechnical engineering analyses were performed to develop recommendations for site earthwork and the reinforced-concrete pad foundation.

It was determined that the location for the system foundation was underlain with undocumented fill and that excavation and re-compaction would be needed to meet JPL standards for minimizing differential settlement of the pad. A detailed report of the geotechnical analysis can be found in Appendix 3-3.

3.3 Soil Compaction

The excavation efforts were started by removing all asphalt that was impacted by the placement of the facilities foundation. The first phase of starting the foundation was to excavate the area where the in-ground sump pit was going to be located. The depth of the sump (11 ft) required the installation of shoring.

The site was excavated to approximately 10 ft bgs, extending out at least 5 ft from the foundations footprint. The excavated soils were screened for any material larger than 3 inches in size. Screening all soil produced approximately 48 tons of construction debris to be removed from the site. The construction debris consisted of rock, steel pipe, PVC pipe, etc.

During the compaction process the soil required the addition of water to obtain the proper compaction results. Water from the JPL fire hydrant was used to aid in compaction and as a form of dust control for safety. The amount of water used was estimated visually and confirmed to be an appropriate amount by the soils engineer.

The compaction process required that the soil be added and compacted in 8 inch lifts to obtain optimum compaction. The compacting was performed using a roller/vibration type compactor.

3.4 Compaction Testing

Confirmation on proper compaction was performed after 3 ft of compaction had occurred. A surface nuclear density gauge was used to test the soil compaction rating and moisture content. Compaction testing was done in random locations so that the most accurate representation of the soils compaction could be reported. All soil compaction tests showed a compaction rating of 95 percent or greater. Figure 3-1 shows field

personnel conducting compaction testing. Field reports from soil compaction testing can be found in Appendix 3-4.

Figure 3-1. Compaction Testing on August 9, 2004

4.0 PLANT CONSTRUCTION

The construction of the OU-1 treatment plant was initiated in July 2004 and completed in January 2005. Plant construction includes the concrete pad, electrical systems, plumbing, and treatment equipment.

4.1 Concrete Pad

The concrete pad design was submitted to the JPL facility and approval of the design was obtained in July 2004. The construction of the concrete pad was divided into three different phases, forming, rebar tying, and pouring. The first phase of construction was building all the proper forms. The placement of the forms involved surveying, stabilizing, and precision measuring to insure the quality of the pad. Verification reports were created to show that rebar was installed to design as Appendix 4-1.

All electrical conduits and grounding grids needed to be installed before pouring concrete could take place. The installation of a grounding grid and conduit placement can be viewed in the as-built drawings as Appendix 4-2.

The concrete pour of the structure was broken down into 5 different pouring events so that the concrete could be finished before drying. Table 4 -1 shows the amount of concrete used in each pour. This division of pours allowed for the most efficient method of building the structure.

Table 4-1. Concrete Usage

Location	Amount (yards)	Type (psi)
Sump	18	5000
Western half of pad	115	5000
Eastern half of pad	116	5000
Pad walls/Footing	27	5000
Elevated Surfaces	43	5000

During each concrete pour, samples of concrete were collected to conduct testing. The samples collected during the concrete pours achieved the design compressive strength of 5,000 psi within 28 days testing results are located in Appendix 4-3.

4.2 Electrical

An electrical design was submitted to JPL facilities and approved in August 2004. The electrical feed to the OU-1 treatment system is located at JPL Bank 63. This JPL bank is located in plot D-3 on the JPL site map, Appendix 3-1. The following field changes to the approved electrical design were necessary:

- Changes in the routing and location of electrical conduit.
- Installation of an extra electrical vault.
- Use of above grade installation in some areas

All changes were reviewed, and agreed upon, by JPL facilities and the electrical designers. The electrical as-built drawings are included as Appendix 4-2.

4.3 Plumbing

A design of all plumbing in the OU-1 treatment system was approved by JPL facilities for construction in July 2004. Plumbing routes are located both above and below grade, and span from Building 310 parking lot north to Pioneer Rd. All above grade plumbing was painted to provide ultraviolet (UV) light protection, while accommodating the JPL facility paint scheme. The following field changes to the approved pipeline design were necessary:

- Rerouting of influent and effluent water pipelines.
- Rerouting of potable water connection.
- Rerouting of sewer discharge pipeline.
- Installation of above ground sewer sampling box.
- Change in wellhead layout.

All changes were reviewed, and agreed upon, by JPL facilities and the civil engineer. As-built drawings of all pipeline routes are included as Appendix 4-4.

Hydraulic testing was performed on the pipelines before they were put into operation. The hydraulic testing consisted of filling the lines to operating pressure and checking all joints for leaks or stress.

4.4 Mechanical Layout

A design of the mechanical layout for the OU-1 treatment plant was approved by JPL Facilities in July 2004. The layout was unchanged from the original design and as-built drawings of the mechanical layout and unit process operations are included as Appendix 4-4. Table 4-2 provides a description of major components of the treatment plant. Figure 4-1 shows a three dimensional drawing of the OU-1 treatment plant.

Table 4-2.. Components of the OU-1 Treatment System

Name	Reference to Figure 4-2	Description
Granular Activated Carbon Vessels	A-1, A-2	These vessels are the first phase of treatment. They are used to filter out VOCs.
T-202	B	This tank is used when backwashing and filling the GAC vessels.
T-201	C	T-201 is the fluidized bed reactor (FBR) feed tank; its purpose is to supply extracted water to the FBR pump skid.
FBR Skid	D	This skid provides the constant flow of water through the FBR unit.
FBR	E	The reactor is where the biological perchlorate removal takes place.
T-401	F	This aeration tank introduces oxygen back into the water.
F-501	G	This is a tri-media filter responsible for cleansing the water of any impurities.
T-501	H	This tank is where treated water is stored before being reinjected into the aquifer.
T-801	I	This sump pit is responsible for holding F-401's backwash flush water. The sump is also a part of the self-containment function.

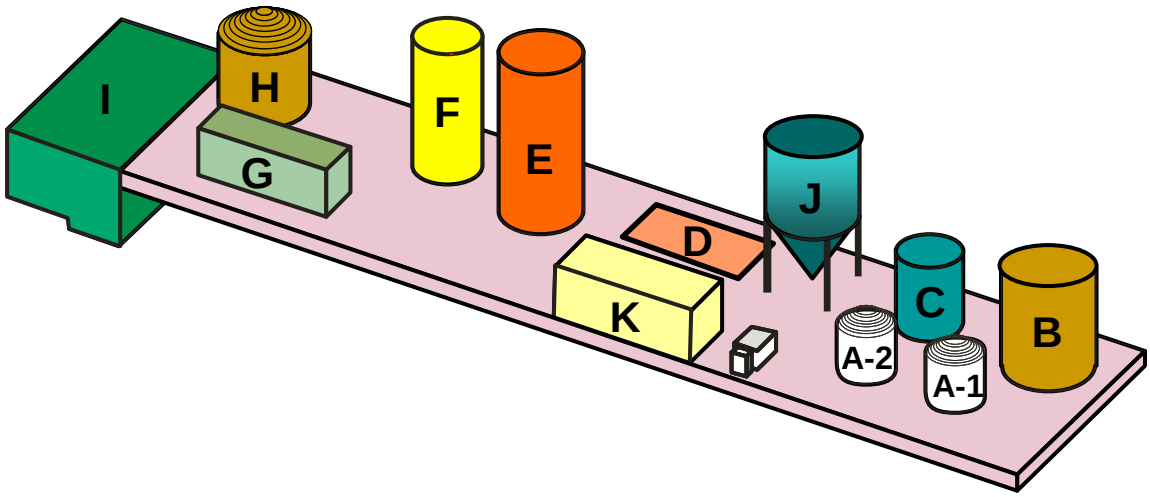

Figure 4-2. OU-1Treatment System Layout

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